NASA CASE NO. NPO-13091-1
PRINT FIG. The Figure

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NPO

AWARDS ABSTRACT

Inventors: Dan A. Bathker [redacted]
Samuel A. Brunstein NASA Case [redacted]. NPO-13091
Arthur C. Ludwig [redacted]

Contractor: Jet Propulsion Laboratory

DUAL FREQUENCY MICROWAVE REFLEX FEED

The primary object of the invention is to provide a dual frequency feed system for a Cassegrainian antenna wherein the two frequencies may be transmitted along a single boresight or received simultaneously using a single antenna.

The drawing shows an S-band feed 18, whose output is reflected by an ellipsoidal reflector 20 onto a planar dichroic reflector 12, which reflects these signals toward a sub-reflector 14. The sub-reflector then redirects the signals onto the main reflector 16 whereby they are directed toward desired target. An X-band feed directs signals at the sub-reflector 14 through the planar dichroic reflector 12 which is transparent to the X-band signals. The sub-reflector directs the S-band signals at the main reflector 16 in a manner so that they are along the same boresight as the S-band signals. By reciprocity, the system can receive S and X band signals which are directed at the antenna along the same boresight.

The primary novel feature of the invention is the disposition of the reflectors including the use of a reflector which is transparent to one of the signals being used to accomplish the objects of the invention.

Application Serial No. 290,022
Filed: September 18, 1972

Contractor: Caltech/JPL
Contract NAS7-100

N75-12214

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Filed: September 18, 1972

NASA Case NO. NPO-13091

SPECIFICATION

TO ALL WHOM IT MAY CONCERN:

BE IT KNOWN THAT DAN A. BATHKER, a citizen of the United States of America, residing at La Crescenta, in the County of Los Angeles, State of California; SAMUEL A. BRUNSTEIN, a citizen of the United States of America, residing at Salt Lake City, in the County of Salt Lake, State of Utah; ARTHUR C. LUDWIG, a citizen of the United States of America, residing at Sun Valley, in the County of Los Angeles, State of California; have invented a new and useful

DUAL FREQUENCY MICROWAVE REFLEX FEED

of which the following is a specification:

ABSTRACT OF THE DISCLOSURE

A dual frequency feed system for a Cassegrainian antenna is provided wherein two frequencies may be transmitted along a single boresight or received simultaneously using a single antenna.

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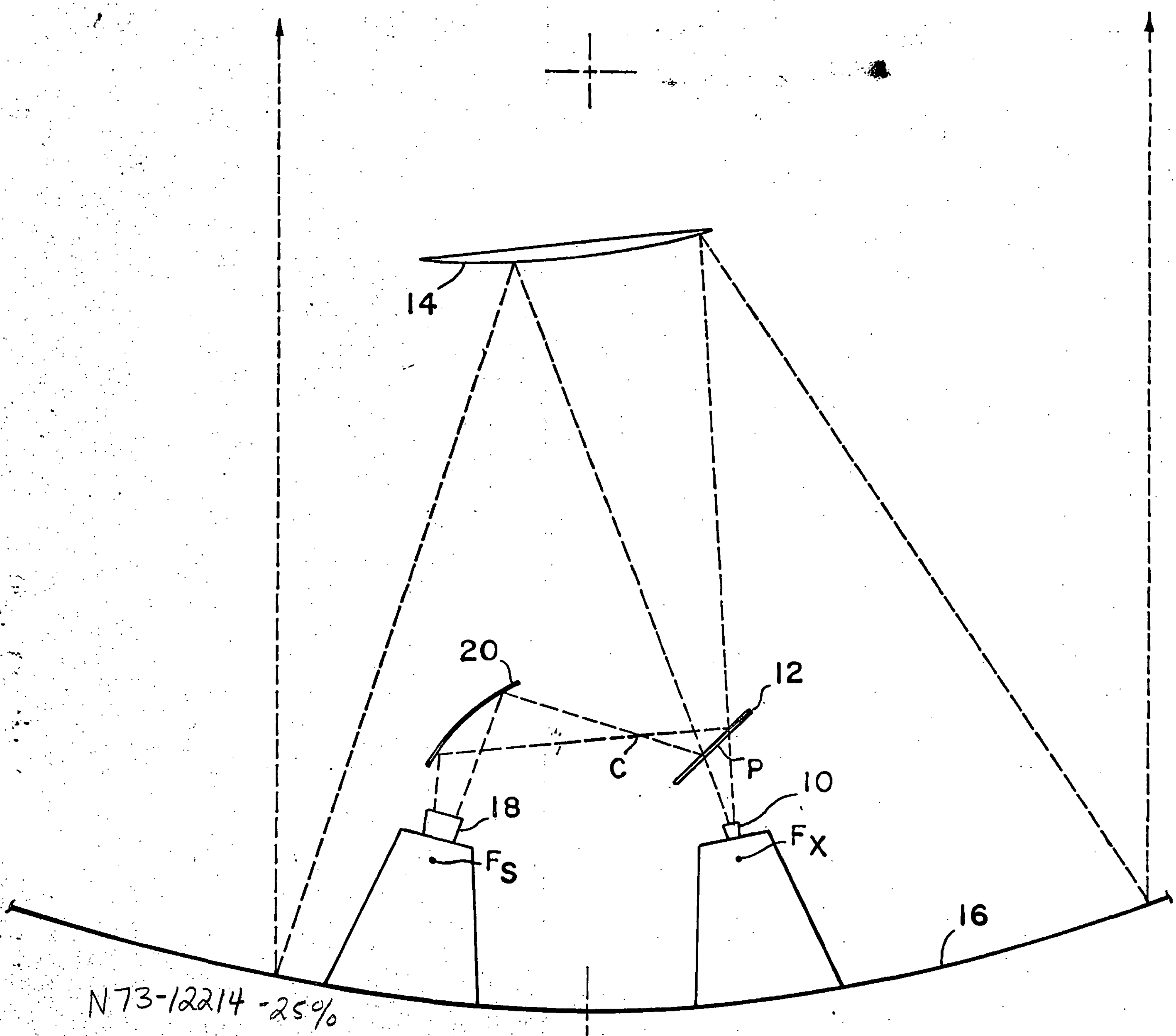

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ORIGIN OF THE INVENTION

The invention described herein was made in the performance of work under a NASA contract and is subject to the provisions of Section 305 of the National Aeronautics and Space Act of 1958, Public Law 85-568 (72 Stat. 435; 42 USC 2457).

BACKGROUND OF THE INVENTION

This invention relates to dual frequency feed systems for Cassegrainian antennas, and more particularly to improvements therein.

For the purpose of making dispersive measurements to study the interplanetary charged particle environment in proposed unmanned spacecraft missions to Venus, and Mercury, it is desired to receive coherent S- and X-band spacecraft signals at earth simultaneously. Because of costs together with transmitter receiver technicalities involved, it is desirable that a single ground antenna, such as a 64 meter Cassegrainian antenna be used for reception of the signals. That single antenna simultaneously also supports high power, diplexed, stable S-band transmission to the spacecraft, from which the stable and coherent downlinks to earth are derived.

One proposed feed for solving this problem has been to use a large Cassegrainian reflector with a curved dichroic sub-reflector positioned in the usual location approximately at the main reflector focal point. Near the center of the main reflector, there is positioned an X-band radiator which radiates the X-band signal toward the dichroic sub-reflector. The dichroic sub-reflector reflects the signal toward the Cassegrainian or main reflector, which then reflects the X-band signal in the usual forward direction. An S-band feed which is positioned behind the dichroic sub-reflector, radiates the S-band signal, which passes through the dichroic sub-reflector toward the main reflector, which in turn reflects the S-band signal in the same forward direction.

The X-band feed therefore operates in a Cassegrainian mode of operation, while the S-band feed operates in a Focal Point mode of operation. The system separates the X-band and S-band feeds and is not conducive to the easy maintenance and adjustments of the two receiving equipments for optimum performance. An all Cassegrainian arrangement retains receiving (and transmitting) equipment at the center of the main reflector, which is reasonably accessable.

Another proposed feed for solving this problem, ~~has been to employ a plurality of elements, at the~~

Cassegrainian focus, with some form of space sharing. Whereas, in principle, this solution maintains the all Cassegrainian arrangement, difficult problems arise in retaining high transmitted power capability simultaneously with low noise receiving ability at two frequencies.

OBJECTS AND SUMMARY OF THE INVENTION

An object of this invention is the provision of a dual frequency feed arrangement for two different frequencies, whereby both frequencies operate in the same mode.

Another object of this invention is the provision of a two frequency feed system whereby both feeds are separated but located closely together at a desirable location near the main reflector for easy handling.

Yet another object of the present invention is the provision of a novel and useful arrangement for feeding two frequencies along the same boresight direction using a single antenna and with a simultaneous propagation mode.

Still another object of this invention is the retention of separately or independently designed

feeds, each optimally arranged for separate or singular operation, and thence the combination of these elements to function simultaneously.

A final object of the present invention is the principle of forming focal points, where required, as a function of frequency.

The foregoing and other objects of the invention are achieved by propagating the S-band signals from an S-band horn toward an ellipsoidal reflector. The ellipsoidal reflector redirects the S-band signal onto a planar dichroic reflector, which is at an angle such that the S-band signals are redirected toward the sub-reflector of the antenna. An X-band horn radiates X-band signals which pass through the planar dichroic reflector toward the sub-reflector, along the same path as the S-band signals. Thus, both S-band and X-band signals are propagated, or received along the same boresight.

The novel features of the invention are set forth with particularity in the appended claims. The invention will best be understood from the following description when read in conjunction with the accompanying drawings which is a schematic illustration of an embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

A source of X-band signals, represented by an X-band horn 10, radiates the X-band signals with no change in their direction, through a dichroic plate 12. The signals continue until they strike a sub-reflector 14, which reflects them toward the Cassegrainian reflector 16.

A source of S-band signals, represented by an S-band horn 18, radiates S-band signals toward an ellipsoid reflector 20. The ellipsoid reflector reflects and focuses the S-band signal in front of the dichroic plate 12 a distance (cp) equal to the distance of the X-band phase center FX below the plate ($\overline{F_X P}$). By positioning the angular position of the dichroic plate correctly, the S-band signals are reflected by it in line with the X-band signal toward the sub-reflector 14.

If desired to use the individual horns in a normal manner, retracting mechanisms can be provided to retract one or both reflectors as required.

By reciprocity, the operation of the reflex feed is the same in the receiving mode as in the transmitting mode.

The dichroic reflector 12, is a planar reflector which is perforated with an array of X-band

slots, thereby making the reflector essentially transparent to the X-band, but reflective to the S-band. The dichroic plate is a well known piece of antenna hardware being described for example, in a publication such as the Ohio State University Technical Report 2148-6, 1967.

There has been accordingly described and shown herein a novel and useful dual frequency microwave reflex feed system, wherein both frequencies operate in a single mode and whereby losses and noise temperature are reduced.

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